



**DEFENSE ACQUISITION UNIVERSITY**  
**Business, Cost Estimating and Financial Management Department**

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**TEACHING NOTE**

**INTRODUCTION TO COST ANALYSIS**

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**BACKGROUND**

All Department of Defense (DoD) Military Departments and Defense Agencies (herein referred to as “DoD Components”) prepare *life cycle cost estimates (LCCEs)* in support of their acquisition programs. A LCCE attempts to identify all the costs of an acquisition program, from its initiation through disposal of the resulting system at the end of its useful life and to properly phase, or spread, the costs for inclusion in budget submission documents.

LCCEs for DoD systems serve two primary purposes. First, they are used at acquisition program milestone and decision reviews to assess whether the system’s cost is *affordable*, or consistent with the DoD Component’s and DoD’s overall long-range investment and force structure plans. Second, LCCEs form the basis for budget requests to Congress.

As in other aspects of acquisition management, maximum use should be made of the Integrated Product and Process Development (IPPD) concept and Integrated Product Teams (IPTs) in the development and review of LCCEs.

**THE DEFENSE LIFE CYCLE MANAGEMENT SYSTEM**

New acquisition programs arise from the existence of either warfighting deficiencies or opportunities to provide new capabilities as documented in Initial Capabilities Document (ICD). The ICD describes the broadly defined operational capability required to satisfy a deficiency and documents reasons why non-materiel changes (e.g., tactics or doctrine) cannot meet this need, thereby requiring a materiel solution (i.e., an acquisition program). These broad capabilities are then refined into system operational requirements consistent with the type of system proposed to remedy the mission need.

Based on all known requirements, the program office prepares an initial LCCE for its acquisition program. As the program passes through its various phases and milestone decision points, the LCCE is updated by the program office and reviewed by decision makers. In the cases of major weapon system and major automated information system (AIS) acquisitions, at least one additional LCCE must be prepared by an organization independent of the program office and the acquisition chain of command (see “Cost Estimating/Analysis Review Process” section later in this note.)

For weapon system acquisition programs, the LCCE helps decision makers assess the affordability of the system. For AIS acquisition programs, the LCCE provides input for the required *cost-benefit analysis*. The cost-benefit analysis enables decision makers to assess whether the AIS will produce satisfactory returns for the investment.

LCCEs are prepared in terms of *base year dollars* (also known as *constant year dollars*) for a selected base year (usually the year of program initiation or last major milestone review). For budgeting purposes, the estimate is escalated to *then year dollars* (also known as *current year dollars*) to reflect inflation and outlay patterns, and is used as the basis for input to the Planning, Programming, Budgeting and Execution (PPBE) process. These estimates ultimately become the foundation for the program's funding request in the President's Budget submitted to Congress.

## **THE LIFE CYCLE COST MODEL**

*Life cycle cost (LCC)* can be defined as the total cost to the government of a program over its full life, including costs for research and development, testing, production, facilities, operations, maintenance, personnel, environmental compliance, and disposal. Each of the program's stakeholders (Congress, program office, contractors, and DoD decision makers) prefers to view life cycle costs grouped in a way that reflects its particular perspective. The three major ways of grouping and viewing program LCC are by:

(1) ***Funding appropriation:*** DoD receives appropriations from Congress falling into five major categories: Research, Development, Test and Evaluation (RDT&E), Procurement, Operations and Maintenance (O&M), Military Construction (MILCON), and Military Personnel (MILPERS). Program life cycle costs are broken out along these lines for internal budgets, as well as budget requests to Congress.

(2) ***Work Breakdown Structure (WBS):*** A program WBS provides a framework for program and technical planning, cost estimating, resource allocations, performance measurements, and status reporting. The WBS should define the total system to be developed or produced; display the total system as a product-oriented hierarchy composed of hardware, software, services, data, and facilities; and relate the elements of work to one another, as well as to the end product. Major acquisition program offices shall tailor a program WBS in accordance with MIL-HDBK-881A. Although handbooks are normally for guidance only, the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD (AT&L)) published a memo on 9 January 2009 (Standardization of Work Breakdown Structures to Support Acquisition Program Management) providing interim guidance on making this handbook mandatory. MIL-HDBK-881A is being turned into a standard again, but as of December 2010, it is still in coordination. Since MIL-HDBK-881A does not address AIS programs, managers of these programs should develop their own program-specific WBS in consultation with appropriate IPT members. Cost breakouts by WBS elements are useful to the program office and contractors in managing the program.

(3) ***Life cycle cost categories:*** DoD 5000.04-M, Cost Analysis Guidance and Procedures, defines these cost categories:

- ***Research & Development (R&D):*** Cost of all research and development, from program initiation through the Full Rate Production decision (end of engineering and manufacturing development for grandfathered programs).
- ***Investment:*** Cost of the investment phase, including total cost of procuring the prime equipment; related support equipment; training; initial and war reserve spares; pre-planned product improvements and military construction.

- **Operating and Support (O&S):** Cost of operating and supporting the fielded system, including all direct and indirect costs incurred in using the system, e.g., personnel, maintenance (unit and depot), and sustaining investment (replenishment spares). The bulk of life cycle costs occur in this category.
- **Disposal:** Cost to dispose of the system after its useful life. This includes demilitarization, detoxification, long-term waste storage, environmental restoration and related costs.

DoD decision makers and program managers use cost categories to establish life cycle cost objectives associated with the concept of Cost as an Independent Variable (CAIV). *(Note: The Investment category for CAIV management purposes can be split into two parts: Procurement and Military Construction).*

Table 1 shows some typical distributions of costs for major system types based on cost estimates prepared by the military components cost analysis agencies.

System Type	R&D	Investment	O&S/Disposal
Space	18%	66%	16%
Fixed Wing Aircraft	20%	39%	41%
Rotary Wing Aircraft	15%	52%	33%
Missiles	27%	33%	39%
Electronics	22%	43%	35%
Ships (note 1)	1%	31%	68%
Surface Vehicles	9%	37%	54%
AIS (note 2)		30%	70%

*Source: Status of DoD's Capability to Estimate the Cost of Weapon Systems: 1999 Update*

**Table 1**

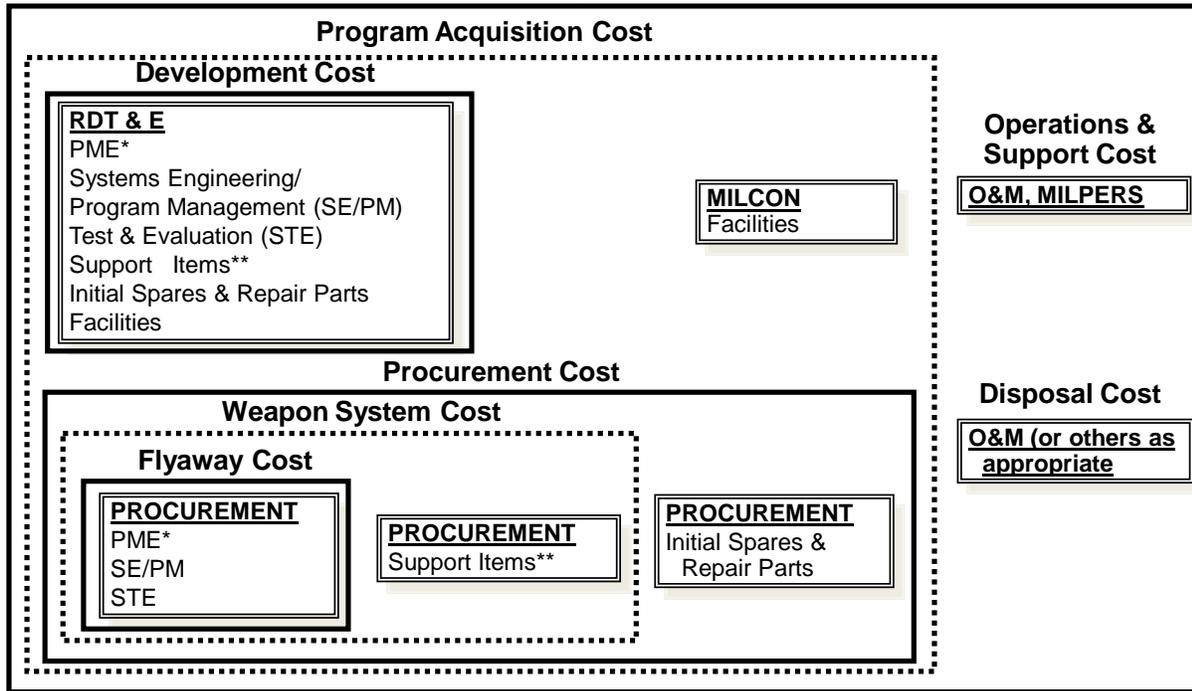
- Notes:** (1) Most ship design costs are included in production cost of lead ship of a class  
 (2) Available data precludes split of pre-O&S costs into R&D and Investment categories

### **Common Cost Terms**

DoD uses a number of different cost terms in various PPBE documents, such as the Program Objectives Memoranda (POM), Budget Estimate Submissions (BES), etc.; in acquisition program reports such as the Defense Acquisition Executive Summary (DAES) and the Selected Acquisition Report (SAR); and in various congressional information sheets. The seven cost terms shown in **Figure 1** have been standardized to ensure consistency in the defense acquisition process. DoD 5000.04-M specifically defines what is included or excluded from each term and identifies relationships to WBS elements, funding appropriations and cost categories. Note that a WBS element can be funded by multiple appropriations.

# Life Cycle Cost Composition

## Life Cycle Cost



\* Prime Mission Equipment (PME) includes all hardware and software WBS elements installed on the weapon system (aircraft, ship, tank, automated information system, etc)

\*\* Support Items include training, data, peculiar and common support equipment, and operational site activation.

**Figure 1**

In Figure 1, the appropriation(s) which may be covered by a particular cost term are shown in bold and underlined at the top of the cost term box. The items shown below the appropriation(s) describe the segments of the WBS that are included in that cost term.

- **Development Cost** is the cost of all research and development-related activities, contract and in-house, necessary to design and test the system. It includes all WBS elements. Prototypes and test articles are included in this cost category. Development costs are funded with only the RDT&E appropriation and are included only in the R&D cost category.

- **Flyaway Cost** (*Rollaway, Sailaway, etc.*) refers to the cost of procuring prime mission equipment (e.g., an aircraft, ship, tank, etc.). It is funded with Procurement appropriations and is part of the Investment cost category. Figure 1 shows that this term includes Prime Mission Equipment, System Engineering/Program Management, System Test and Evaluation, Warranties, and Engineering Changes. (*Note: DoD 5000.4-M defines flyaway cost as being funded out of the RDT&E and Procurement appropriations, but in practice, only the Procurement-funded portion of flyaway is considered relevant by decision makers in DoD and in Congress.*)

- **Weapon System Cost** is funded completely from the Procurement appropriations. It is the procurement counterpart of Development Cost in that it contains the same WBS elements as Development Cost. Weapon System Cost consists of the Flyaway Cost plus the additional WBS elements shown in Figure 1.

- **Procurement Cost** is also funded completely from the Procurement appropriations. It includes Weapon System Cost plus the WBS element of initial spares. For Navy shipbuilding programs, outfitting and post-delivery costs are also included when these costs are Procurement-funded.

- **Program Acquisition Cost** is a multi-appropriation cost. It consists of all costs associated with developing, procuring and housing a weapon system. Because it consolidates development, procurement and military construction costs, RDT&E, Procurement and MILCON appropriations are included. This is the complete cost of acquiring a weapon system - ready to operate.

- **Operating and Support Costs** are funded primarily with the O&M and Military Personnel appropriations. However, RDT&E, Procurement, and/or MILCON appropriations may also be used, as appropriate, based on the nature of the effort, after the weapon system has been deployed. This category includes all costs for personnel, equipment, and supplies associated with operating, modifying, maintaining and supporting a weapon system in the DoD inventory. This includes all direct and indirect costs. These costs do not include any of the development costs, procurement costs or any other part of the program acquisition costs for the weapon system, nor do they include any disposal costs for the weapon system. Because the system is already fielded, the MIL-HDBK 881 WBS does not apply to this cost term.

- **Life Cycle Cost** includes all WBS elements, all appropriations, and all cost categories. As shown in Figure 1, it is the sum of Program Acquisition Cost, Operating and Support Cost, and Disposal Cost for a system.

### **Time Phasing of Costs**

In addition to looking at program costs aggregated in the various ways discussed above (i.e., appropriations, WBS and life cycle cost categories), we must also be able to determine when these costs will be incurred. Obviously, all costs of a program are not incurred during one fiscal year and, because DoD requests and receives funding annually from Congress, we need to allocate the costs to the fiscal years when funds will be required. The time phasing of funding requirements is particularly important in the PPBE process. This topic is addressed in a separate teaching note entitled "Building the Program Budget."

### **Risk**

By its very nature, a cost estimate is uncertain. A Program Office Estimate (POE) is a point estimate of the ultimate cost of a future weapon system. A great deal of uncertainty is associated with the development of a new weapon system and the estimate of its cost. Quantifying this inherent uncertainty provides useful additional information to the decision maker. Uncertainty in cost estimates arises from many sources and may be grouped into three categories: requirements, cost estimating, and technical. Although these uncertainties occur simultaneously in practice, each is treated analytically independent of the other with sensitivity analysis or mathematical probability techniques.

### **TOTAL OWNERSHIP COST**

In light of shrinking defense budgets, DoD is focusing on reducing the overall cost of the DoD establishment and its major subdivisions (i.e., the DoD Components), with the goal of freeing up funding for modernization and recapitalization of weapon systems. Total Ownership Cost (TOC)

is defined as the sum of financial resources needed to organize, equip, sustain, and operate the system, while meeting national goals, policies, and standards of readiness, environmental compliance, safety, and quality of life concerns. The TOC for Defense systems consists of the costs to research, develop, acquire, own, operate, and dispose of weapon and support systems. The TOC of a Defense system should be the same as its Life Cycle Cost (LCC).

LCC includes not only acquisition program direct costs, but also the indirect costs attributable to the acquisition program (i.e., costs that would not occur if the program did not exist). For example, indirect costs would include the infrastructure that plans, manages, and executes a program over its full life and common support items and systems.

Acquisition program managers are charged with minimizing TOC through the continuous reduction of LCC for their systems. DoD TOC reduction efforts are being implemented by all DoD Components.

### **COST ANALYSIS REQUIREMENTS DESCRIPTION (CARD)**

Analysts need extensive information about an acquisition program in order to estimate its cost to the detail required by the various display formats identified in the life cycle cost model. This information is provided in the document known as the *Cost Analysis Requirements Description (CARD)*. The CARD completely describes the system whose costs are to be estimated; it should define the program in sufficient detail so that no confusion exists among the many parties who may be concerned with estimating the program's cost. DoD 5000.04-M provides guidance regarding CARD preparation.

Per the DoD 5000 series, a CARD shall be prepared for all ACAT I and ACAT IA programs. The DoD component sponsoring the acquisition program is responsible for preparation of the CARD, in coordination with appropriate IPT members. The CARD should be considered a "living document," updated in preparation for all milestone and program reviews, if not annually. The updates reflect any changes that have occurred, or new data that have become available, since the previous milestone or program review. DoD Instruction 5000.02 requires ACAT I and IA programs to update the CARD at Program Initiation for Ships (which may begin during the Technology Development phase), at Milestone B, at Milestone C, and at the Full Rate Production Decision Review. A draft version of the CARD is required 180 days prior to the milestone or decision review; the final version is required 45 days prior to the milestone or decision review. Preparation of the CARD should be coordinated with other program documents so that all final program documents are consistent with one another.

### **COST ESTIMATING/ANALYSIS REVIEW PROCESS**

#### **Legal and Regulatory Requirements**

- **Title 10, United States Code, Section 2434** requires that the Secretary of Defense consider an independent estimate of the life cycle cost of a Major Defense Acquisition Program (MDAP) cost prior to granting Milestone B (Milestone II for grandfathered programs) and Milestone C (Low Rate Initial Production) approval. This LCCE is known as the "*Independent Cost Estimate*" (*ICE*). This independent estimate must be produced by an entity outside the development and acquisition chain(s) of command.

- **Title 44, United States Code, Section 3506 and the Clinger-Cohen Act of 1996, Section 5122** require that cost-benefit analysis be performed for all Major Automated Information System (MAIS) acquisitions.

- **DoD Instruction 5000.02** implements the legal requirements above and mandates additional cost estimating requirements for ACAT I (MDAP) and ACAT IA (MAIS) programs. Requirements for preparation and review of LCCEs for these programs are summarized below:

- The **Cost Assessment Directorate** performs the ICE for all ACAT ID programs and for certain ACAT IC programs as requested by the USD (AT&L). This ICE is prepared for Milestone B (Milestone I for grandfathered programs), Milestone C (Milestone II for grandfathered programs) and the Full Rate Production Decision Review (Milestone III for grandfathered programs). Component cost analysis agencies that are not part of the development or acquisition chain are tasked to complete the statutorily required independent LCCE for remaining ACAT IC programs. The regulation also requires that the Program Office prepare a LCCE (known as the **Program Office Estimate (POE)**) in support of program initiation. The POE is to be updated for each subsequent milestone and decision review. For ACAT ID programs with significant cost risk or high visibility, the Component Acquisition Executive (CAE) may request a **Component Cost Estimate (CCE)** be prepared in addition to the POE and the Cost Assessment Directorate ICE.

- For **ACAT IA** programs, neither law nor regulation prescribes an ICE; however, the DoD 5000 series does require the cognizant OSD Principal Staff Assistant or sponsoring DoD Component ensure that a CCE is created at Program Initiation and each time the MDA requests an Economic Analysis. The regulation also requires that the Program Office prepare a POE in support of program initiation and all subsequent milestone and decision reviews. Unlike an ACAT I POE, the ACAT IA POE must include life cycle *benefits* as well as life cycle costs. The cost/benefit element structure must be agreed to by the program's IPT.

### **OSD Cost Assessment Directorate**

The OSD Cost Assessment Directorate acts as the principal advisory body to the OIPT (Overarching Integrated Product Team), the **Defense Acquisition Board (DAB)** and the Secretary of Defense on matters relating to cost. It contains the expertise from the old OSD CAIG. Formal names for the process and review group are still being developed. Until the new names are formalized, we will continue to use the term CAIG to describe the OSD group responsible for the independent assessment of cost estimates. **The Deputy Director, Cost Assessment Directorate is dual-hatted as the CAIG chair.** The CAIG membership consists of the CAIG Chair; one member appointed by each permanent DAB member; and *ad hoc* representatives as appointed by the CAIG Chair. Members of the CAIG represent their functional areas. The OSD CAIG has the following functions:

- (1) Provide feedback to the component based on its independent review of the LCCE(s), validate the methodology used to make the estimate(s); and determine whether additional analysis is required.

- (2) Provide the DAB with a review and evaluation of the POE and CCE (if one is prepared).

(3) Provide the DAB with an independent analysis of cost implications of significant DAB issues (e.g., co-production in multinational programs, competitive alternative sources, alternative acquisition strategies, etc.).

(4) Provide a recommendation as to the reasonableness of the new Program Acquisition Unit Cost and Current Procurement Unit Cost for the Secretary of Defense certification to Congress for programs breaching established thresholds.

(5) Establish guidance on preparing cost estimates and detailed procedural guidance on CAIG presentations.

(6) Maintain an integrated cost analysis research program.

(7) Establish standard definitions of cost terms for DoD acquisition programs.

(8) Establish guidance pertaining to the Cost and Software Data Reporting (CSDR) system and monitoring its implementation.

(9) Establish policy for and administer the Visibility and Management of Operating and Support Costs (VAMOSC) program.

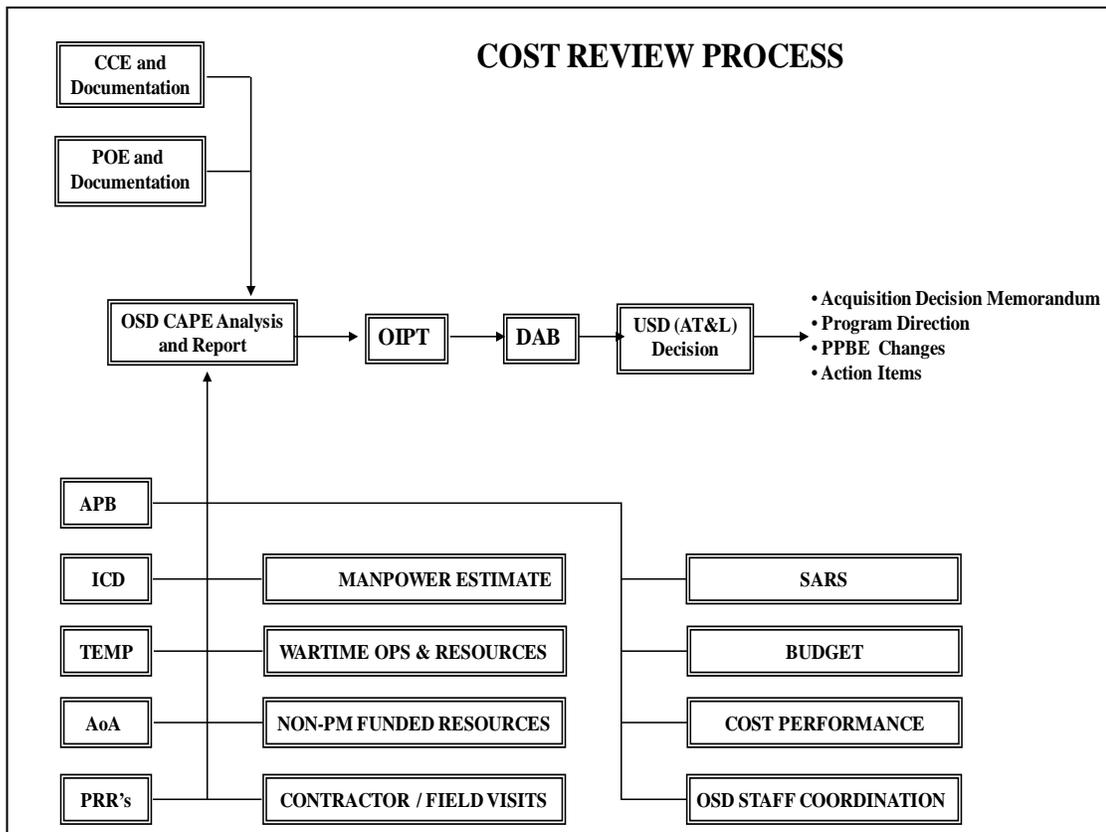
**Component Cost Analysis Agencies**

All DoD Components have established their own agencies to serve as their lead organization for cost analysis and cost estimating actions and to act as liaison between the component and the OSD CAIG. Program office personnel involved with conducting or reviewing POEs should be aware of their respective Component’s agency and contact that organization as appropriate on cost related issues. **Figure 2** provides information about how to contact each of these component agencies, as well as the OSD CAIG.

<u>Component</u>	<u>Organization</u>	<u>Phone</u>	<u>Web Site</u>
Army	Deputy Assistant Secretary of the Army for Cost and Economics	(703) 692-1722 DSN 222-1722	<a href="http://www.asafm.army.mil/ceac/ceac.asp">http://www.asafm.army.mil/ceac/ceac.asp</a>
Air Force	Air Force Cost Analysis Agency (AFCAA)	(703) 604-0387 DSN 664-0387	<a href="http://www.saffm.hq.af.mil">www.saffm.hq.af.mil</a> <i>(select AFCAA tab)</i>
Navy	Naval Cost Analysis Division (NCAD)	(703) 692-4899 DSN 222-4899	<a href="http://www.ncca.navy.mil">www.ncca.navy.mil</a>
OSD	Cost Assessment and Program Evaluation Directorate (CAPE)	(703) 695-0721 DSN 225-0721	<a href="http://www.pae.osd.mil">www.pae.osd.mil</a>

**Figure 2**

## The Cost Review Process



**Figure 3**

**Figure 3** displays the cost review process for obtaining a Secretary of Defense program decision for a major weapon system. Each service prepares for the OSD CAIG meeting differently. In each service, the program team prepares the POE with in-house or contractor personnel. However, non-government personnel are not allowed at the CAIG meeting. The CCE, if required, is prepared by the component's cost analysis agency, if one exists, or by some other office independent of the acquisition and development chain of command.

**Army:** The Office Deputy Assistant Secretary of the Army for Cost and Economics prepares the CCE and briefs the results to the CAIG. The Army Cost Review Board works with the Assistant Secretary of the Army (Financial Management & Comptroller) to develop the Army cost position briefed to the CAIG.

**Navy:** The Naval Center for Cost Analysis (NCCA) prepares and briefs the CCE to the CAIG. The Navy holds a reconciliation meeting prior to the formal CAIG meeting.

**Air Force:** The Air Force Cost Directorate, SAF/FMC, prepares the AF cost position, after reconciliation between the System Program Office estimate and the AF Cost Analysis Agency's CCE.

The CAIG report takes into consideration all the factors and information shown in the bottom portion of Figure 3. There must be cost consistency among all documents.

## **SUMMARY**

Life cycle cost estimates are essential sources of information for the materiel acquisition process. They provide the cost information to support the acquisition milestone decision process as well as the development of acquisition program budget requests.

Life cycle costs can be viewed from three different perspectives: funding appropriations, WBS and life cycle cost categories. Funding appropriations refer to the major categories of appropriations with which Congress provides DoD budget authority: RDT&E, Procurement, MILCON, MILPERS, and O&M. The WBS breaks down costs into hardware-related categories and helps ensure that no costs are overlooked. The life cycle cost categories (R&D, Investment, O&S, and Disposal) are designed primarily for the use of DoD decision makers.

At each milestone beginning with program initiation, as many as three life cycle cost estimates (the POE, the ICE and the CCE) may be prepared to support the acquisition decision process for a new system. Except when specific estimates are required by law, the program's milestone decision authority decides which estimates will be prepared to support each milestone and decision review.

### REFERENCES:

<https://akss.dau.mil/dapc/index.aspx> - The DoD 5000 directive and instruction series

<https://km.saffm.hq.af.mil/ASPs/CoP/CostCoP.asp?Filter=OO-FM-CE> – Air Force cost portal (site registration required)

<https://afkm.wpafb.af.mil/ASPs/CoP/Entry.asp?Filter=OO> - resources concerning National Security Space acquisition policy (site registration required).

<http://www.ncca.navy.mil/about/101.cfm> - The Navy's cost center.

<http://www.asafm.army.mil/ceac/ceac.asp> - The Army's cost center.